THE FATE OF RHONE RIVER CARBON AND NUTRIENTS IN THE COASTAL MEDITERRANEAN SEA AND ITS RELATION TO CLIMATIC PARAMETERS

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Abstract

The Rhone River exerts a major influence on the Gulf of Lions which is the largest river-dominated ocean margin of the Western Mediterranean Sea. The biogeochemical fate of the Rhone River inputs (dissolved nutrients, particulate organic matter and detrital particles) was investigated during a multi-compartment study (CHACCRA) by coupling simultaneous measurements on the river inputs, the river plume processes and the benthic deposition. A coupled physical-biogeochemical model was used to link the inputs and their fate in the Gulf of Lions and to investigate the sensitivity of the delta system to changes in climate and in river inputs.

Keywords: Deltas, Global Change, Gulf Of Lions, Organic Matter, Rhone Delta

The Rhone River exerts a major influence on the Gulf of Lions which is the largest river-dominated ocean margin of the Western Mediterranean Sea. The biogeochemical fate of the Rhone River inputs (dissolved nutrients, particulate organic matter and detrital particles) to the continental shelf is largely influenced by primary production in the plume, deposition patterns of particles and transformation processes in the water column and sediments. We have designed a multi-compartment study (CHACCRA) by coupling simultaneous measurements on the river inputs, the river plume processes and the benthic deposition to elucidate the transport and transformation of Rhone River material in the Gulf of Lions. A coupled physical-biogeochemical model is used to link the inputs and their fate in the Gulf of Lions. First results from the river input monitoring show that the river input of organic material is highly variable in quantity showing intra and inter-annual variability. The largest change in quality of organic input is linked to the occurrence of floods in the Rhone watershed which may deliver either more reactive carbon (originating from the river bed and runoff on vegetated soils) or less reactive when delivered from erosion of soils. The benthic deposition and transformation of this material shows a spatial pattern with a focus of the deposition of river organic matter as tracked by ^{13}C and ^{14}C signature and an intense recycling of organic particles close to the river mouth. Oxygen demand values close to the Rhone River outlet are around 20 mmol m^{-2} d^{-1}, remain high up to a distance of 10 km around the river mouth above 10 mmol m^{-2} d^{-1} (called the prodelta) and decrease to average continental shelf values further away [1]. This pattern is stable over the seasons but is disturbed by the occurrence of floods which, in the case of June 2008, spread low-reactivity material in the nearshore region and significantly decreased benthic recycling during a few months. The measurements performed during the three cruises dedicated to plume processes showed limited accumulation of Chlorophyll *a* in the Rhone River dilution zone, due to low flow rates during these periods. The structure of the pelagic food web was oriented towards recycling except on a single occasion where marine snow was recorded in the intermediate layer of the water column indicating benthic-pelagic coupling. Overall, a disconnection between river plume production regions occurring on the distant shelf (>30 km) and the hot spot of benthic recycling in the nearshore region is apparent. Biogeochemical modelling coupled to the Symphonie hydrodynamics model in the Gulf of Lion showed a first-order agreement with the timing and amplitude of the winter-spring bloom on the western part of the shelf. The Rhone River plume required specific parametrization, since its biogeochemistry is significantly different from the rest of the Gulf of Lion: stratification is stronger, nutrients are more abundant, the food web is oriented towards larger species. This specific model reproduced the succession of the different nutrients pools and planktonic groups along the Rhone freshwater dilution zone described by [2]. The model was used to characterize the biogeochemical functioning of the Gulf of Lion and to compute associated budgets during several years contrasted by their hydrological and meteorological forcing. The importance of floods and low flow rates on the delivery and fate of organic material to the Rhone prodelta points towards a vulnerability of the ecosystem with respect to climatic change. Climate change should alter both river hydrography due to stronger extreme rains, dry periods and wind patterns in the Northwestern Mediterranean. These changes will be investigated, together with the human impact through the delivery of contaminants and nutrients, in the framework of the newly launched MERMEX programme.

References

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